

IN THE CLAIMS

1. (Currently amended) A multi-output DC-DC converter comprising:

_____ an inductor (L),

_____ a main switch (S_0) for periodically coupling a DC-input voltage (V_{in}) to the inductor (L),

_____ a ~~multitude~~plurality of output switches (S_1, S_2, S_3) coupled to the inductor (L), each one for generating an associated one of a ~~multitude~~plurality of output voltages (V_1, V_2, V_3) to an associated one of a ~~multitude~~plurality of loads (L_1, L_2, L_3), and

_____ a controller (1) for controlling the main switch (S_0) and the output switches (S_1, S_2, S_3) in a sequence (SE) of cycles (CY_1, CY_2, CY_3), each one of the cycles (CY_1, CY_2, CY_3) comprising an on-phase (TO_1, TO_2, TO_3) of the main switch (S_0) followed by an on-phase (T_1, T_2, T_3) of one of the ~~multitude~~plurality of the output switches (S_1, S_2, S_3), _____ the controller (1) comprising:

_____ a ~~multitude~~plurality of comparators ($10, 11, 12$) each one for comparing an associated one of the ~~multitude~~plurality of output voltages (V_1, V_2, V_3) with an associated one of a ~~multitude~~plurality of reference voltages (VR_1, VR_2, VR_3), _____ means for determining (13) whether a number of the output voltages (V_1, V_2, V_3) which have a value above their associated reference voltage (VR_1, VR_2, VR_3) is larger than, smaller than, or equal to a number of the ~~multitude~~plurality of output voltages (V_1, V_2, V_3) which have a value below their associated reference voltage (VR_1, VR_2, VR_3), _____ means for generating (14) the cycles (CY_1, CY_2, CY_3) either with a first duty cycle (D_1) or a second duty cycle (D_2) being larger than the first duty cycle (D_1) to

obtain a first number ~~(N1)~~ of cycles ~~(CY1, CY2, CY3)~~ with the first duty cycle ~~(D1)~~ and a second number ~~(N2)~~ of cycles ~~(CY1, CY2, CY3)~~ with the second duty cycle ~~(D2)~~, the first number ~~(N1)~~ being: (1) larger than the second number if the number of the output voltages which have a value above their associated reference voltage is larger than the number of the plurality of output voltages which have a value below their associated reference voltage; (2) smaller than the second number if the number of the output voltages which have a value above their associated reference voltage is smaller than the number of the plurality of output voltages which have a value below their associated reference voltage; or (3) equal to the second number the second number if the number of the output voltages which have a value above their associated reference voltage is equal to the number of the plurality of output voltages which have a value below their associated reference voltage ~~(N2)~~, respectively.

2. (Currently amended) A multi-output DC-DC converter as claimed in claim 1, wherein the first number ~~(N1)~~ is equal to the number of output voltages ~~(V1, V2, V3)~~ which have a value above their associated reference voltage ~~(VR1, VR2, VR3)~~, and wherein the second number ~~(N2)~~ is equal to the number of output voltages ~~(V1, V2, V3)~~ which have a value below their associated reference voltage ~~(VR1, VR2, VR3)~~.

3. (Currently amended) A multi-output DC-DC converter as claimed in claim 2, wherein the means for generating ~~(14)~~ the cycles comprises a sequencer ~~(140)~~ for controlling an order of the cycles ~~(CY1, CY2, CY3)~~ in a sequence ~~(SE)~~ wherein, as much as possible at the present values of the first number ~~(N1)~~ and the second number ~~(N2)~~, one of the cycles

~~(CY1, CY2, CY3)~~ with the second duty cycle ~~(D2)~~ precedes one of the cycles ~~(CY1, CY2, CY3)~~ with the first duty cycle ~~(D1)~~.

4. (Currently amended) A multi-output DC-DC converter as claimed in claim 2, wherein the means for generating ~~(14)~~ the cycles comprises a sequencer ~~(140)~~ for controlling an order of the cycles ~~(CY1, CY2, CY3)~~ in a sequence ~~(SE)~~ to first comprise all the cycles ~~(CY1, CY2, CY3)~~ with the second duty cycle ~~D2~~ and then all the cycles ~~(CY1, CY2, CY3)~~ with the first duty cycle ~~(D1)~~.

5. (Currently amended) A multi-output DC-DC converter as claimed in claim 2, wherein the means for generating ~~(14)~~ the cycles comprises a means for allocating ~~(141)~~: the first number ~~(N1)~~ of the first duty cycles ~~(D1)~~ as much as possible to cycles ~~(CY1, CY2, CY3)~~ associated with output voltages ~~(V1, V2, V3)~~ that have a value below their corresponding reference voltage ~~(VR1, VR2, VR3)~~, and the second number ~~(N2)~~ of the second duty cycles ~~(D2)~~ as much as possible to cycles ~~(CY1, CY2, CY3)~~ associated with output voltages ~~(V1, V2, V3)~~ which have a value above their corresponding reference voltage ~~(VR1, VR2, VR3)~~.

6. (Currently amended) A multi-output DC-DC converter as claimed in claim 5, wherein the means for allocating ~~(141)~~ the number of duty cycles is adapted for further allocating the first duty cycle ~~(D1)~~ to cycles ~~(CY1, CY2, CY3)~~ associated with output voltages ~~(V1, V2, V3)~~ that have a value above their corresponding reference voltage ~~(VR1, VR2, VR3)~~ if the first number ~~(N1)~~ is larger than the number of output voltages ~~(V1, V2, V3)~~ that

have a value below their associated reference voltage (~~VR1, VR2, VR3~~).

7. (Currently amended) A multi-output DC-DC converter as claimed in claim 5, wherein the means for allocating (~~141~~) is adapted for further allocating the second duty cycle (~~D2~~) to cycles (~~CY1, CY2, CY3~~) associated with output voltages (~~V1, V2, V3~~) that have a value below their associated reference voltage (~~VR1, VR2, VR3~~) if the second number (~~N2~~) is larger than the number of output voltages (~~V1, V2, V3~~) that have a value above their associated reference voltage (~~VR1, VR2, VR3~~).

8. (Currently amended) A multi-output DC-DC converter as claimed in claim 5, wherein the means for allocating (~~141~~) is adapted for allocating to a predetermined one of the cycles (~~CY1, CY2, CY3~~) in a sequence (~~SE~~) wherein a lowest amount of energy is transferred to one of the output voltages (~~V1, V2, V3~~) of which the value is above the associated reference voltage (~~VR1, VR2, VR3~~).

9. (Currently amended) A multi-output DC-DC converter as claimed in claim 5, wherein the means for allocating (~~141~~) is adapted for allocating as a first one of the cycle (~~CY1, CY2, CY3~~) in a sequence (~~SE~~) an output voltage (~~V1, V2, V3~~) of which the value is above the associated reference voltage (~~VR1, VR2, VR3~~) and to which a first duty cycle (~~D1~~) is allocated.

10. (Currently amended) A multi-output DC-DC converter as claimed in claim 5, wherein the means for allocating (~~141~~) is adapted for allocating to a predetermined one of the

cycles (~~CY1, CY2, CY3~~) in a sequence (~~SE~~) wherein a highest amount of energy is transferred to one of the output voltages (~~V1, V2, V3~~) of which the value is below the associated reference voltage (~~VR1, VR2, VR3~~).

11. (Currently amended) A multi-output DC-DC converter as claimed in claim 5, wherein the means for allocating (~~141~~) is adapted for allocating, in a sequence (~~SE~~), a last cycle (~~CY1~~) to which a second duty cycle is allocated to an output voltage (~~V1, V2, V3~~) of which the value is below the associated reference voltage (~~VR1, VR2, VR3~~) and to which a second duty cycle (~~D2~~) is allocated.

12. (Currently amended) A multi-output DC-DC converter as claimed in claim 5, wherein the means for allocating (~~141~~) is adapted to allocate in a next sequence (~~SE~~) the second duty cycle (~~D2~~) to a particular one of the output voltages (~~V1, V2, V3~~), if in a preceding sequence (~~SE~~) the first duty cycle (~~D1~~) is allocated to this particular one of the output voltages (~~V1, V2, V3~~) while the associated reference voltage (~~VR1, VR2, VR3~~) is lower.

13. (Currently amended) A multi-output DC-DC converter as claimed in claim 5, wherein the means for allocating (~~141~~) is adapted to allocate in a next sequence (~~SE~~) the first duty cycle (~~D1~~) to a particular one of the output voltages (~~V1, V2, V3~~), if in a preceding sequence (~~SE~~) the second duty cycle (~~D2~~) is allocated to this particular one of the output voltages (~~V1, V2, V3~~) while the associated reference voltage (~~VR1, VR2, VR3~~) is higher.

14. (Currently amended) A multi-output DC-DC converter as claimed in 1, the multi-

output DC-DC converter further comprising mode detectors ~~(15)~~, each one being associated with one of the multiple output voltages ~~(V1, V2, V3)~~ for keeping track of a mode of each one of a multiple outputs ~~(O1, O2, O3)~~, each mode detector having three states ~~(0, 1, 2)~~, a first state ~~(0)~~ indicating whether no load current is drawn from the associated output ~~(O1, O2, O3)~~, a second state ~~(1)~~ and a third state ~~(2)~~ wherein load current is drawn from the associated output ~~(O1, O2, O3)~~, if the associated output ~~(O1, O2, O3)~~ is in the first state ~~(0)~~ and the associated output voltage ~~(V1, V2, V3)~~ is smaller than its associated reference voltage ~~(VR1, VR2, VR3)~~ the third state ~~(2)~~ is entered, if the associated output ~~(O1, O2, O3)~~ is in the first state ~~(0)~~ and the associated output voltage ~~(V1, V2, V3)~~ is larger than its associated reference voltage ~~(VR1, VR2, VR3)~~ the first state ~~(0)~~ will be maintained, if the associated output ~~(O1, O2, O3)~~ is in the second state ~~(1)~~ and the associated output voltage ~~(V1, V2, V3)~~ is larger than its associated reference voltage ~~(VR1, VR2, VR3)~~ the first state ~~(0)~~ is entered, if the associated output ~~(O1, O2, O3)~~ is in the second state ~~(1)~~ and the associated output voltage ~~(V1, V2, V3)~~ is smaller than its associated reference voltage ~~(VR1, VR2, VR3)~~ the third state ~~(2)~~ is entered, if the associated output ~~(O1, O2, O3)~~ is in the third state ~~(2)~~ and the associated output voltage ~~(V1, V2, V3)~~ is smaller than its associated reference voltage ~~(VR1, VR2, VR3)~~ the third state ~~(2)~~ is maintained, if the associated output ~~(O1, O2, O3)~~ is in the third ~~(2)~~ state and the associated output voltage ~~(V1, V2, V3)~~ is larger than its associated reference voltage ~~(VR1, VR2, VR3)~~ the second state ~~(1)~~ is entered.

15. (Currently amended) A multi-output DC-DC converter as claimed in 14, the means ~~(14)~~ for generating the cycles further comprising a sequence controller ~~(142)~~ for

controlling a number of cycles (~~CY~~) required in a sequence (~~SE~~) such that cycles (~~CY~~) are generated only for outputs (~~O1, O2, O3~~) that are in the second state (~~1~~) or the third state (~~2~~).

16. (Currently amended) An apparatus comprising the multi-output DC-DC converter as claimed in claim 1.

17. (Currently amended) A method of controlling a multi-output DC-DC converter comprising: an inductor (~~L~~), a main switch (~~S0~~) for periodically coupling a DC-input voltage (~~Vin~~) to the inductor (~~L~~), a ~~multitudeplurality~~ of output switches (~~S1, S2, S3~~) coupled to the inductor (~~L~~), each one for supplying an associated one of a ~~multitudeplurality~~ of output voltages (~~V1, V2, V3~~) to an associated one of a ~~multitudeplurality~~ of loads (~~L1, L2, L3~~), the method comprising: controlling (~~1~~) the main switch (~~S0~~) and the output switches (~~S1, S2, S3~~) in a sequence (~~SE~~) of cycles (~~CY1, CY2, CY3~~), each one of the cycles (~~CY1, CY2, CY3~~) containing an on-phase (~~TO1, TO2, TO3~~) of the main switch (~~S0~~) followed by an on-phase (~~T1, T2, T3~~) of one of the ~~multitudeplurality~~ of the output switches (~~S1, S2, S3~~), the method of controlling (~~1~~) comprising:

_____ comparing (~~10, 11, 12~~) a corresponding one of the ~~multitudeplurality~~ of output voltages (~~V1, V2, V3~~) with an associated one of a ~~multitudeplurality~~ of reference voltages (~~VR1, VR2, VR3~~),

_____ determining (~~13~~) whether a number of the output voltages (~~V1, V2, V3~~) that have a value above their associated reference voltage (~~VR1, VR2, VR3~~), is larger than, smaller

than, or equal to a number of the ~~multitude~~plurality of output voltages (~~V1, V2, V3~~) that have a value below their associated reference voltage (~~VR1, VR2, VR3~~), and _____ means for generating (14) the cycles (~~CY1, CY2, CY3~~) either only with a first duty cycle (~~D1~~) or a second duty cycle (~~D2~~) being larger than the first duty cycle (~~D1~~) to obtain a first number (~~N1~~) of cycles (~~CY1, CY2, CY3~~) with the first duty cycle (~~D1~~) and a second number (~~N2~~) of cycles (~~CY1, CY2, CY3~~) with the second duty cycle (~~D2~~), the first number (~~N1~~) being: (1) larger than the second number if the number of the output voltages which have a value above their associated reference voltage is larger than the number of the plurality of output voltages which have a value below their associated reference voltage; (2) smaller than the second number if the number of the output voltages which have a value above their associated reference voltage is smaller than the number of the plurality of output voltages which have a value below their associated reference voltage; or (3) equal to the second number if the number of the output voltages which have a value above their associated reference voltage is equal to the number of the plurality of output voltages which have a value below their associated reference voltage larger than, smaller than, or equal to the second number (~~N2~~), respectively.